RECOMMENDED PRACTICE

FOR

PREPARATION OF NOTATIONS

THE INDIAN ROADS CONGRESS

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INTRODUCTION

The Bridges Committee of Indian Roads Congress in its meeting held in September, 1975 took note of the developments in international acceptance of a common logical system of notations and set up a Panel to recommend a system of notations in conformity with the same.

The following members served on the Panel :

P.C. Bhasin	*Convenor*
D.T. Grover	
D. Ajitha Simha	
Dr. V.K. Raina	

The draft standard framed by the Panel was approved by the Bridges Committee in their meeting held on the 9th to 11th May 1977 and then by the Executive Committee. Later it was approved by the Council in their 90th meeting held on the 29th July 1977.

The object of issuing this Standard is to establish the usage of a logical and uniform system of notations in all IRC Standards as well as in all technical literature, design calculations and drawings. Certain changes necessary may cause inconvenience in initial use. But, an immediate and rigid adherence is recommended to achieve the desired results in shortest possible time. Suggestions for improvement of the Standard, arising out of practical use, are most welcome and may be sent to the *Secretary*, Indian Roads Congress, Jamnagar House, Shahjahan Road, New Delhi-110011.

1. SCOPE

This standard recommends the practice to be followed in preparing symbols to be used in notation defining any aspect of bridge construction.

2. DEFINITION

Notation is defined as a system of symbols formed in a logical manner to represent definitions of engineering concept, for the purpose of this standard.

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3. CONSTRUCTION OF SYMBOLS

A symbol shall consist of :

(i) *a leading letter*,
to be chosen according to 4.

(ii) *a descriptive subscript, added where necessary*,
to be chosen according to 5.

(iii) indices and signs, where *necessary* according to 6.
(*see Appendix I typical notations for a concrete beam,
Appendix II Symbols for unit, Appendix III Common
mathematical signs or symbols*).

4. LEADING LETTER

4.1. A leading letter shall be selected from :

(i) Roman upper case letters

(ii) Roman lower case letters

(iii) Greek lower case letters

Greek upper case letters are reserved for mathematics and not recommended for use in notations, within the scope of this standard.

4.2. The selection of the leading letter of symbol shall be based on the consideration of the dimensions of the physical quantity involved, as given hereafter. Concepts not included shall comply with the nearest appropriate category listed.

Some exceptions have been adopted in deference to traditional practice. These are indicated at appropriate places and should be carefully noted.

Some letters are generally prohibited from use to avoid confusion. These are indicated as VOID in Tables 1, 2 and 3.

4.2.1. Roman uppear case letters

shall denote quantities with the following dimensions :

(i) Force

(ii) Force times length

(iii) Area to a power

(iv) Temperature

4.2.1.1. An *exception* shall be made in case of the modulus of elasticity, the modulus of shear, which shall be denoted by Roman upper case letters i.e. E,G. respectively (for 'exception regarding optional use of L in place of l, see Table 2).

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4.2.1.2. The following quantities shall be denoted generally by Roman upper case letters (see Table 1 for a more detailed description) :

   (i) Concentrated load, total load, normal force, shear,

   (ii) Moment,

  (iii) Area, first or second moment of area, volume,

  (iv) Temperature,

   (v) Modulus of elasticity, modulus of shear.
       (exception to dimensions 4.2.1.)

4.2.1.3. Table 1 gives a detailed description of the recommended usage of Roman upper case letters :

TABLE 1.   ROMAN UPPER CASE LETTERS—FOR USE AS
LEADING LETTER

Letter	Denotes	Remarks
A	area	
B	—	
C	torsional moment of inertia	
D	—	
E	modulus of elasticity	
F	load, force	shall include all actions including imposed deformations
G	modulus of shear, dead load	
H	—	
I	moment of inertia	
J	—	
K	any coefficient with proper dimensions	
L	—	can be used in lieu of lower case l to denote 'span, length of member' (see Table 2), when confusion with 1 (numeral) is likely in typescript.
M	bending moment	
N	normal force	
O	VOID	
P	prestressing force	

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Table 1 (contd.)

Letter	Denotes	Remarks
Q	live load	
R	—	
S	first moment of area	
T	torsional moment, temperature	
U	—	
V	shear force, volume	
W	wind load, section modulus $(W = I/y)$	
X	reactions or forces in general parallel to axis x	
Y	reactions or forces in general parallel to axis y	
Z	reactions or forces in general parallel to axis z.	

Note :   1. A blank space against a letter means that the same is unassigned and not prohibited.

       2. The letters indicated as VOID are generally prohibited from use.

4.2.2. Roman lower case letters

shall denote quantities with the following dimensions :

  (i) length

  (ii) length per time to a power

  (iii) force per unit length or area.

4.2.2.1. (i) An *exception* shall be made in case of symbols to be used for stress. Greek lower case letters shall be used for denoting stress (strength) e.g. normal stress, shear stress etc., to be indicated by σ, τ respectively.

(ii) The diameter of a reinforcing bar or tendon shall be indicated by the Greek lower case letter ϕ, as an *exception*.

4.2.2.2. The following quantities shall be denoted generally by Roman lower case letters (see Table 2 for more detailed description) :

  (i) Linear dimensions (for exception see 4.2.2.1. ii)

  (ii) Velocity, acceleration,

  (iii) Unit moment/shear/normal force/load, force per unit area (exception for stress, see 4.2.2.1. i).

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4.2.2.3. Table 2 gives a detailed description of the recommended usage of Roman lower case letters :

TABLE 2. ROMAN LOWER CASE LETTERS—FOR USE AS LEADING LETTER

Letter	Denotes	Remarks
a	deflection; distance	
b	width	
c	concrete cover	
d	effective depth, diameter	diameter of reinforcing bar indicated by ϕ, see 4.2.2.1. and table 3.
e	eccentricity	also used in mathematics to denote base of Naperian logarithm.
f	strength	
g	distributed dead load; acceleration due to gravity	
h	total depth or diameter of a cross-section; thickness	
i	radius of gyration	
j	number of days	
k	any coefficient with proper dimensions	
l	span; length of member	can be replaced by L when ambiguity with 1 (numeral may) arise.
m	bending moment per unit length or width	
n	normal force per unit length or width	also used in mathematics to denote number
o	VOID	
p	VOID	
q	distributed live load	
r	radius	

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Table 2 (contd.)

Letter	Denotes	Remarks
s	standard deviation, spacing	
t	time, torsional moment per unit length or width	
u	perimeter	
v	shear force per unit length or width, velocity	shall not be used for shear stress, see 4.2.2.1. and Table 3
w	distributed wind load, crack width	
x	co-ordinate, depth of neutral axis	
y	co-ordinate, depth of rectangular stress block	
z	co-ordinate lever arm	

Note : 1. The meanings given here are not necessarily valid for subscripts for which Table 4 may be referred.

2. A blank space against a letter means that the same is unassigned and not prohibited.

3. The letters indicated as VOID are generally prohibited from use.

4.2.3. Greek lower case letters

shall denote dimensionless terms

4.2.3.1. (i) As an exception, stress (strength) shall be denoted by Greek lower case letters, see 4.2.2.1.

(ii) The diameter of a reinforcing bar or tendon shall be denoted by ϕ, as an exception.

4.2.3.2. The following quantities shall be denoted generally by Greek lower case letters

(i) Coefficient and dimensionless ratio
(ii) Strain
(iii) Angle
(iv) Stress (strength) (exception to dimensions 4.2.3.)
(v) Diameter of a reinforcing bar or tendon (exception to dimensions 4.2.3.)

4.2.3.3. Table 3 gives a detailed description of the recommended usage of Greek lower case letters:

TABLE 3.   LOWER CASE GREEK LETTERS—FOR USE AS
LEADING LETTER

Letter		Denotes	Remarks
Alpha	α	angle, ratio, coefficient	
Beta	β	angle, ratio, coefficient	
Gamma	γ	specific gravity, safety factor, shear strain (angular deformation)	
Delta	δ	coefficient of variation, coefficient	
Epsilon	ε	strain	
Zeta	ζ	coefficient	
Eta	η	VOID	
Theta	θ	rotation	
Iota	ι	VOID	
Kappa	κ	VOID	
Lambda	λ	slenderness ratio, coefficient	
Mu	μ	coefficient of friction	
Nu	ν	Poisson's ratio	
Xi	ξ	coefficient	
Omicron	o	VOID	
Pi	π	(mathematical usage only)	$\pi = 3,14159$
Rho	ρ	geometrical ratio of reinforcement	
Sigma	σ	normal stress	exception to dimensions 4.2.
Tau	τ	shear stress	exception to dimensions 4.2.
Upsilon	υ	VOID	
Phi	φ	diameter of reinforcing bar or tendon, coefficient	exception to dimensions 4.2.
Chi	χ	VOID	
Psi	ψ	coefficient	
Omega	ω	VOID	

Note : 1. A blank space against a letter means that the same is unassigned and not prohibited.

2. The letters indicated as VOID are generally prohibited from use.

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5. SUBSCRIPT

5.1. The subscript shall be formed by Roman lower case letters or numerals or a combination of them. Roman upper case letters or Greek letters are not recommended to be used in subscript.

5.2. Multiple subscript should be avoided as long as there is little likelihood of confusion. Multiple subscript, when required to be used, may be formed by a group of Roman lower case letters or numerals or by standard abbreviation of words.

When confusion is possible, a bar may be placed over a multiple subscript or a comma (,) may be used to distinguish between two categories of subscripts used together. Tables 4, 5 and 6 give a detailed description of the recommended usage of subscript of different types.

Subscripts other than those given in Tables 4, 5 and 6 shall be used only with a clear written definition of their meanings indicated.

TABLE 4. GENERAL SUBSCRIPTS

Letter	Denotes	Remarks
a	support settlement, additional	
b	bond, bar, beam	
c	concrete, compression, column	
d	design value	
e	elastic, effective	
f	forces and other actions, flange, flexure, friction	
g	dead load	
h	horizontal	
i	initial	
j	number of days	
k	characteristic	
l	longitudinal	
m	average values, materials	
n	number	
o	VOID	only the meaning of numeral O is accepted
p	prestress	

Table 4 (contd.)

Letter	Denotes	Remarks
q	live load	
r	cracking	
s	steel, slab	
t	torsion, tension, transversal	
u	ultimate (limit state)	
v	shear, vertical	
w	web, wind	
x	linear co-ordinate	
y	linear co-ordinate, yield	
z	linear co-ordinate	
Numerals		
0, 1, 2.... particular value of quantities		

TABLE 5. SUBSCRIPTS FOR LOADS AND OTHER ACTIONS

Letter	Denotes
g	dead load
q	live load
w	wind
ep	earth pressure
eq	earthquake
im	impact
a	support settlement
p	prestress
cc	concrete creep
cs	concrete shrinkage
te	temperature

TABLE 6. SUBSCRIPTS FORMED FROM ABBREVIATIONS

Abbreviation	Denotes
adm	admissible, permissible
cal	calculated
crit	critical
exc	exceptional
ext	external
inf	inferior, lower
int	internal
lat	lateral
lim	limit
max	maximum
min	minimum
obs	observed
sup	superior, upper
tot	total
var	variable

6. INDICES AND SIGNS

A prime (') may be added to a symbol representing geometrical quantity to indicate compression, if required. Use of any other superscript is not recommended. Sign of computed stress may be given by $+$ (plus) for tension and $-$ (minus) for compression.
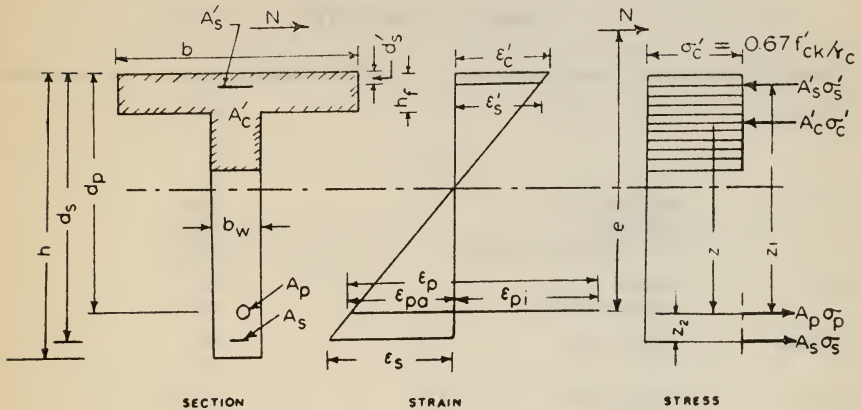
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TYPICAL NOTATIONS FOR A CONCRETE BEAM

Fig. 1   Typical Notations for a Concrete Beam: Analysis of Section

Notation	Denotes
A'_c	Area of concrete in compression
A_p	Area of prestressing steel
A_s	Area of reinforcing steel in tensile flange
A'_s	Area of reinforcing steel in compression flange
b	width of flange
b_w	width of web
d'_s	effective depth of compressive steel reinforcement
d_p	effective depth of prestressing steel
d_s	effective depth of tensile steel reinforcement
e	eccentricity of load
f'_{ck}	characteristic compressive strength of concrete
h	total depth of section
h_f	depth of flange
z, z_1, z_2	lever arm
γ_c	material safety factor for concrete
ε'_c	strain in concrete—compressive
ϵ_{pa}	additional load strain in prestressing steel
ϵ_{pi}	strain in prestressing steel due to initial prestressing
ϵ_p	strain in prestressing steel
ϵ_s	strain in steel reinforcement—tensile
ϵ'_s	strain in steel reinforcement—compressive
σ'_c	stress in concrete—compressive
σ_p	stress in prestressing steel
σ_s	stress in steel reinforcement—tensile
σ'_s	stress in steel reinforcement—compressive

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SYMBOLS FOR UNITS

Quantity	Name of Unit	Symbol
length	metre millimetre kilometre (micrometre or micron	m mm km μm)
area	square metre squre millimetre	m² mm²
volume	cubic metre litre	m³ lit
mass	kilogramme gramme tonne	kg gm t
density	kilogramme per cubic metre tonne per cubic metre	kg/m³ t/m³
time	second minute hour day year	s min h j a
temperature	degree Celsius	°C
velocity	metre per second kilometre per hour	m/s km/h
force	newton kilonewton meganewton	N kN MN
moment	newton metre kilonewton metre meganewton metre	N.m kN.m MN.m
pressure/ stress	pascal (newton per square metre) megapascal	Pa (N/m²) MPa (MN/m² or N/mm²)

Note: 1. The symbols are given for SI units. (Technical or other metric units shall not be used. Decimal multiples or submultiples other than those mentioned herein shall also not generally be used).

2. 9.80665 N=1 kgf
For approximate conversion 1 kgf or kg≈10 N and 1 kgf/cm² or kg/cm²≈0.1 MPa.

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3. The symbols shall remain unaltered in plural (it may be noted that s denotes second and as such should never be added to the symbol to indicate plural).

4. The symbols shall be written without a final full stop (period).

5. When symbols for units are combined in product, the process of combination shall be indicated as below:

$$N.m$$
$$N \cdot m$$
$$N\ m$$
but not as Nm

When combined in a quotient, the process of combination shall be indicated as below:

$$kg/m^3$$
$$\frac{kg}{m^3}$$
$$kg.m^{-3}$$
$$kg \cdot m^{-3}$$
but not as kgm^{-3}

Not more than one solidus (/) shall be included in such combinations; parentheses or preferably negative powers shall be used where necessary.

COMMON MATHEMATICAL SIGNS OR SYMBOLS

Sign or Symbol	Denotes	Remarks
$=$	equal to	
$\neq$	not equal to	
$\equiv$	identically equal to	
$\approx$	approximately equal to	
$\rightarrow$	approaches	
$\simeq$	asymptotically equal to	
$\sim$	proportional to	$\propto$ also used
∞	infinity	
$<$	smaller than	
$>$	larger than	
$\leqslant \leq \leqq$	smaller than or equal to	
$\geqslant \geq \geqq$	larger than or equal to	
$\ll$	much smaller than	
$\gg$	much larger than	
Σ	sum	
$\triangle \times$	delta x=finite increment (difference) of x	